

REMARKS

Claims 1-8 are pending in the application. Claims 1 and 5 have been amended, and claims 9 and 10 have been canceled by the present amendment.

Applicants' claimed invention is directed to a ground-ball bonding structure for a TBGA (tape ball grid array) package, which is constructed on a heat sink and a solder-unwetable tape having a via hole penetrating therethrough. A ring-shaped ground-ball pad is formed around the via hole, and a solder mask is applied over the tape while leaving unmasked the ring-shaped ground-ball pad. This ground-ball pad is further formed with a plurality of air vents penetrating through the solder-unwetable tape and extending outwardly from the via hole, wherein a distance between outermost edges of the air vents is **greater than** a diameter of the unmasked ground-ball pad, so as to form an interspaced ring of the ground-ball pad and allow each of the air vents to extend to a position beneath the solder mask.

As shown in FIG. 5A, ring-shaped ground-ball pad 131 is formed with a plurality of air vents 131a spaced substantially at equal intervals around via hole 122. The distance d between outermost edges of the air vents 131a is greater than a diameter D of the ring-shaped ground-ball pad 131, so as to form an interspaced ring of the ground-ball pad and allow each of the air vents to extend to a position beneath the solder mask 140.

As recited in claims 1 and 5 of the Applicants' claimed invention, during a solder-reflow process, a solder material 151a pasted into the via hole can be wetted only to the unmasked interspaced ring of the ground-ball pad 131, but **cannot be wetted** to the solder-unwetable tape 120 encompassing the air vents 131a or filled into the air vents. Therefore, the pasted solder material 151a in a melted state would reflow freely downwards to draw air-filled voids at the bottom of the via hole through the air vents 131a to the outside atmosphere (see page 7, lines 16-24 of the specification).

Claims 1-8 were rejected under 35 USC 103(a) as being unpatentable over "Applicant's Admitted Prior Art (APA)" in view of Japanese Publication 4-2195 to Kitamura (hereinafter "Kitamura"). This rejection is respectfully traversed.

The prior art as embodied in FIGS. 1 and 2A-2F and discussed in the Background section of the application, does not teach or suggest air vents which are connected to the via hole 22 of the tape 20. As discussed on page 3, lines 14-22, air-filled voids 60 are left at the bottom of the via hole 22 during solder-reflow. The resulting ground ball 51 formed over this via hole is not coplanar with other solder balls, which also can lead to degradation of bonding between the ground ball 51 and heat sink 10.

Kitamura fails to teach or suggest a plurality of air vents formed around the via hole where a distance between outermost edges of the air vents is greater than a diameter of the unmasked ring-shaped ground-ball pad, so as to form an interspaced ring of the ground-ball pad. Moreover, Kitamura fails to teach or suggest solder material which is wetted to the unmasked interspaced ring of the ground-ball pad but prevented from being wetted to the solder-unwetttable tape encompassing the air vents.

As shown in FIGS. 1 and 2 of Kitamura, cross-shape through hole 9a is formed through a land (pad) 10a. Protruding ends of the through hole 9a are exposed but do not extend beyond the land 10a to form an interspaced ring shape, as recited in the Applicants' claimed invention. Therefore, in Kitamura, the outermost edges of the air vents are not "**greater than** a diameter of the unmasked ring-shaped ground-ball pad," as required in claims 1 and 5.

In the Office Action (page 6), it was stated that the distance between the edges of the air vent being "at least equal to a diameter of the unmasked pad" constituted "an obvious matter of design choice." However, as explained in the Applicants' specification, the distance *d* between the respective outermost edges of the air vents 131a must be equal to or greater than the diameter *D* of the via hole 122/unmasked pad 131, in order to "allow the outermost ends of the air vents 131a to extend ... beneath the solder mask 140" (page 6, lines 18-21; see also FIG. 5A).

Therefore, criticality of the distance between outermost edges of the air vents 131a has been established in the specification, as this distance should be **greater than** the diameter of the unmasked ring-shaped ground-ball pad 131, so that air can be drawn through the air vents 131a during a solder reflow process.

In Kitamura, because the through hole 9a does not extend beyond the land (pad) 10a, the land 10a does not form an "interspaced ring" as recited in the Applicants' invention. Instead, the arrangement of Kitamura (see FIG. 2) constitutes a continuous ring/pad, as depicted in FIG. 5B of the application (see page 6, lines 18-23), which corresponds to the prior art. For a continuous pad, the solder material is wetted to the continuous pad and thus would cover openings of the air vents on the pad, so that air in the via hole could not be dissipated through the air vents. For example, in Kitamura, if conductive paste 12 is imprecisely coated over the through hole 9a, the protruding ends of the through holes 9a would be covered, and air in the through hole 9a would not be released.

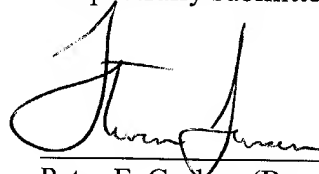
Moreover, as shown in FIG. 2 of Kitamura, conductive paste 12 is partly filled into the protruding ends of the through hole 9a (see also Abstract). In the Applicants' claimed invention, the solder material is "**prevented from being wetted** to the solder-unwettable tape encompassing the air vents" (claims 1 and 5). Kitamura specifically teaches that conductive paste is **filled** in the through hole 9a, where the protruding ends of the through hole 9a are used to release air at the time of coating the conductive paste 12. In the Applicants' claimed invention, during a first solder-pasting process, air voids are formed and left in the via hole; in a second solder-pasting process, due to free downward reflow of the solder material (which is not wetted to the tape) in the via hole, the air voids can be drawn to dissipate through the air vents. Therefore, the through hole 9a of Kitamura has a different structure and function from the air vents recited in the Applicants' claimed invention.

Even if Kitamura were somehow combined with the prior art discussed in the Background section of the application, the Applicants' claimed invention could not be produced, for at least the reasons discussed above. For example, in the Applicants' claimed invention, air

vents are formed around the via hole such that a distance between outermost edges of the air vents is greater than a diameter of the unmasked ring-shaped ground-ball pad, unlike the arrangement of the through hole 9a in Kitamura. Moreover, Kitamura fails to teach or suggest solder material which is wetted to the unmasked interspaced ring of the ground-ball pad and prevented from being wetted to the solder-unwetttable tape encompassing the air vents.

It is believed the application is in condition for immediate allowance, which action is earnestly solicited.

Respectfully submitted,



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